1858MNRAS..19...16C

Physical Phenomena of Comet V., 1858, *as observed with the Northumberland Telescope at the Cambridge Observatory.* By Professor Challis.

In the following account of the physical appearances of Donati's Comet observed by myself and my Senior Assistant, Mr. Breen, I have first given the phenomena as recorded in rough notes, or represented by sketches, at the times of observation, and have then added some explanatory and supplementary remarks. The observations were all made with a power of 166, the same that was used in taking positions of the comet by reference to stars, and most probably several details which could only be seen with high powers, have on this account escaped observation. At the same time the advantage was gained of judging with a greater degree of certainty of the variations of brightness and form in the larger features of the phenomenon.

Mr. Breen's observations were as follows:—

"1858, Aug. 19. Comet observed through dense cloud; bright and easily seen in the finder, although the field was too cloudy for seeing any stars." The aperture of the object-glass of the finder is 2¼ inches, focal length 29 inches, and diameter of the field of view 115′.

"Aug. 23. Bright, but no trace of a tail; the sky clear, but the moon nearly at full.

"Aug. 27. Condensed nucleus. Aug. 30. Tail to north.

"Sept. 7. Very conspicuous to the naked eye, being nearly of mag. 2. Long and broad tail pointed directly north.

"Sept. 13. The nucleus beautifully sharp and stellar; the tail slightly curved and pointing nearly north.

"Sept. 15. Tail 3° in length; a fan-shaped tail to the nucleus opposite to the tail of the comet." A sketch exhibited the nucleus round, with two projections turned from the tail and equally inclined to its axis.

"Sept. 16. Bright and easily observed; power 166 as usual. The tail curved to the preceding direction and nearly north.

"Sept. 17. The nucleus very distinct and well defined. The tail is now slightly curved towards the east." A sketch exhibited the curvature and an excess of brightness on the convex side.

"Sept. 21. The nucleus like a star of the first mag. The tail about 5° in length, as well as I could judge.

"Sept. 24. Comet very brilliant; nucleus well defined; the luminous sector well seen and brightest at the edges." A sketch represented the nucleus as nearly round, surmounted by a luminous sector, which on the side towards the tail was bounded by two arcs tending to form a cusp at the nucleus,

1858MNRAS..19...16C

and on the other side by a semicircular arch, brighter than the space between it and the nucleus. The coma extended beyond this arch, and in the direction of the tail was considerably fainter near the axis than at the sides.

"Sept. 25. Nucleus large and bright; no dark space between it and the arch." A sketch exhibited in other respects the same appearances as on Sept. 24.

"Sept. 27, 7^h. The luminous sector very bright and beautifully seen; the nucleus is now extremely small and bright like a star,—almost dissipated, except a brilliant point,—quite changed since Sept. 25. The tail is getting broader at the end; it could be traced for $7\frac{1}{2}^\circ$ in the finder." According to a sketch, the nucleus was round, and attached to it on the upper side (as seen in the telescope) was a luminous sector, depressed towards the tail on the right side. The coma extended beyond to a distance greater than the radius of the sector, and was terminated by a bright border between which and the sector was a darker space.

"Sept. 30, 8^h. The nucleus again large and planetary; no fantail, but a little rainbow over the nucleus as on Sept. 27. Dark band sharply defined down the tail; the outer boundary of the tail sharp on the right side, and ill-defined on the opposite side." By measurement with the position circle, the axis of the tail was inclined southward from the great circle through the pole by 13°.

"Oct. 5, 7^h. A hole in the fantail adjoining the nucleus." A sketch represented a dark patch on the left side of the nucleus, and within it near the nucleus a bright spot; also a less conspicuous patch above the nucleus.

"Oct. 6. The same appearance as on Oct. 5, but the dark part in the nucleus (?) was not so well or so largely seen, and the left side of the arch was not so well defined."

Oct. 8 and 9. Sketches on these days represented a wing-shaped envelope attached to the nucleus, the arch, as usual, farther off, with coma beyond, and the space dark under the nucleus.

Oct. 11. A sketch indicated two projections from the upper side of the nucleus, turned from the tail, and equally inclined to its axis. The attached envelope and the arch were nearly as before.

Oct. 15 and 16. According to the sketches, the near envelope was broader, and more depressed towards the tail on the left side than on the right side. The arch was marked at about the same distance from the nucleus as before. "The comet had now much faded."

My own observations and sketches were commenced when I perceived that the comet was exhibiting phenomena of a very remarkable character, and unlike any which it had happened to me to witness in any previous instance.

1858MNRAS..19...16C

Sept. 27, 8^h^. A drawing which I took at this time exhibited a small fan-shaped centre, the broader part turned from the tail, and the brightness increasing towards the narrow part which had a small, circular, and very bright termination [which is properly the nucleus]. This central part was surrounded, except for about 90° on the side towards the tail, with a kind of hood or envelope, less bright and much larger than the central part, but bright enough to be in definite contrast with the coma which extended from it to a breadth about equal to its radius. The hood was more depressed towards the tail on the right side (as seen in the telescope) than on the left side. The right side of the tail was also considerably the brighter; the intermediate part was comparatively dark. A star of mag. 8, seen through this part at the distance of a few minutes from the nucleus, exhibited no unusual phenomena. By measurement with a position-circle the axis of the tail was inclined southward from the great circle through the pole by 8°.

"Sept. 30, 7^h^–8^h^. In the finder a narrow dark band well defined was observable along the axis of the tail." My drawing represented the central brightness as larger and more oval than on Sept. 27, and having a round blunt termination at the lower or brightest part. Above the upper part was a less illumined space, increasing in brightness towards a luminous semicircular arch pretty definitely bounded on the outside, beyond which the coma was faintly visible to some extent. This arch descended towards the tail a little more on the right side than on the left. The tail appeared to stream both from the arch and from the exterior and interior coma, and the right-hand stream was considerably the brighter. By a drawing of the appearance to the naked eye, the curvature of the tail was now very considerable, the convexity turned southward, the convex side much the brightest, and the extremity of the tail broad and diffused. Its estimated length was 20°.

"Oct. 2, $7\frac{1}{4}^h$. About the very bright and small nucleus on the upper side was a bright fan or hood, and beyond this a larger hood, with a less illumined space between them. The coma was traceable beyond the second hood. Under the cusp of the nucleus the space was remarkably dark, and a dark and rather broad band divided the tail into two parts which, at a considerable distance from the head, overlapped each other." A drawing represented the right-hand branch of the tail considerably the brighter, but the form and appearance of the head was now symmetrical about its axis. To the naked eye the tail was much more sharply defined on the southern than on the northern side, and was widely spread out at the extremity. Its length was 33°, as measured on a celestial globe, by reference to *Arcturus*, which was very close to the nucleus, and to stars of *Ursa Major*.

"Oct. 5, 7^h^. There were two dark openings in the space

1858MNRAS..19...16C

included by the external arch, the larger on the left side of the nucleus, and the smaller above it. Also between the larger and the nucleus was a bright point, but not so bright as the nucleus." A sketch exhibited these openings as faint patches irregular in form and distribution of light, and the bright point as a small spot of light near the nucleus. The right-hand stream of the tail was the brighter; the nucleus and fan-shaped attachment appeared nearly as on Oct. 2. This evening I looked at the light of the tail with a Nichol's prism and a tourmaline, and found that not far from the nucleus there was some polarisation.

"Oct. 6, 7h. The cusp of the nucleus not so sharp to-night; the left-hand irregular patch seen, but the one above scarcely discernible. There was much cloud about." A sketch exhibited the bright spot on the right-hand border of the irregular patch, and very near the nucleus.

"Oct. 8, 6½h. Mottled appearance about the envelope [*i. e.* the space between the exterior arch and the bright central fan]. The left-hand patch seen, but not the bright spot. Apparently a greater divergence of the coma; the right-hand stream still the brighter." The central fan, as shown in a drawing, was spread out farther than on Oct. 6. To the naked eye the tail appeared more diffused than on Oct. 5, especially at its extremity. The greatest apparent curvature was at the distance from the nucleus of one-fourth its length. The length was but little diminished.

"Oct. 9, 7h. The angular divergence of the streams of coma greater, and the light more diffused; the comet altogether less bright. The bright part of the nucleus and the hood appeared smaller. Clouds about and the sky unfavourable. The axis of the cusp and nucleus not coincident with the axis of the tail." [This appearance was probably owing to the *left* side of the envelope being now extended farther than the right in the direction of the tail.] To the naked eye the tail was fainter and still more diffused than on Oct. 8, but nearly of the same length.

"Oct. 11, 6½h. Greater angular separation of the streams of the tail; the hood not so definitely bounded, the central brightness rounder, probably owing to the state of the atmosphere, the comet being low." A sketch exhibited a determination of the hood towards the left side, but the two streams of the tail of equal intensity. To the naked eye the tail was much spread out laterally, especially at the extreme part, and the nucleus was less bright. The length of the tail was judged by reference to stars to be 30°.

"Oct. 13, 6½h. Comet scarcely to be seen for mist. I endeavoured to estimate the radius of the exterior arch in the direction transverse to the axis of the tail. I think it was 6r of the micrometer, or 52″. [This estimation is very uncertain.]

1858MNRAS..19...16C

Oct. 15, $6\frac{1}{2}^{h}$. The length of the radius of the exterior arch in a direction inclined from its vertex by about 65° was found by measurement to be 4^{r} of the micrometer, or 35″. "The coma was distributed very unsymmetrically about the nucleus, being much more apparent on the lower, or northern side, than on the other. It was too faint on the latter side for measurement of the radius of the arch; there was a good deal of daylight. The boundary of the interior envelope was very definite; that of the exterior arch very indistinct and uncertain. The radius of the former on the apparent lower side was about one-third that of the other, or 12″." The nucleus and attached envelope presented in a sketch the form of an inverted comma. The interior boundaries of the two streams of the tail were confused, the coma spreading over the intermediate space. By measurement with a position circle the axis of the tail was inclined northward from the equatoreal direction by 4°.

"Oct. 16, 6^{h} The comet had nearly the same appearance as on the preceding evening; the comma form of the brightest part was seen in strong daylight; the boundary of the arch was still visible on the apparent lower side. By estimation from the teeth of the comb, its radius transverse to the axis was $4^{r}\cdot 7$, or 41″. According to a drawing, the radius of the brighter part was three-sevenths of this measure, or about 18″. The axis of the tail was nearly in the equatoreal direction."

Professor Challis has appended to the foregoing observations a few explanatory notes, but as they will probably be published at full length in another form, we shall merely quote the following remark:

"In the course of the observations my attention was especially directed to the following particulars, respecting which I can speak with confidence. The brightness contiguous to the nucleus preponderated on the right side (as seen in the telescope) till October 2; and on October 9 the excess had passed to the left side. The excess of brightness of the right-hand stream of the tail above that of the other, attained its maximum about October 2; after which there was a gradual diminution, till, on October 11, 15, and 16, the two streams were not sensibly unequal. The dark band separating the two portions of the tail was of uniform width and definite boundary on September 30 and October 2; and in proportion as the boundaries afterwards became indefinite, and the intervening space was gradually filled with luminosity, the angular divergence of the two streams also increased."